Rapid Ecological Assessment of Forests and Associated Exotic Earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish & Wildlife Service[1]

FOREST COMMUNITY ANALYSIS: Shiawassee NWR

Gradient Analysis. Using relative basal area by species (%) of the 52 plots sampled across seven stands at Shiawassee NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we examined the distribution of overstory species across sampled stands using Non-Metric Dimensional Scaling (NMDS). NMDS is a non-parametric ordination analysis that maximizes the rank-order correlation between distances. Unlike other indirect (e.g., principal components analysis) or direct (e.g., canonical correspondence analysis) ordination techniques, NMDS does not make any assumptions about the nature of the data, including assumptions about the linear relationship among variables. As a result, it is often viewed as an appropriate analysis for ecological data (McCune and Grace 2002).

Prior to the analysis, the relative basal area data by species were transformed using an arcsin squareroot transformation as is appropriate with percentage data. NMDS was then run using PC-ORD (ver. 5.0) software using a Sorenson distance measure. A two-dimensional solution was determined to be the most appropriate (Monte Carlo test, n = 50 runs; Axis 1 *P-value* = 0.196; Axis 2 *P-value* = 0.039).

Based upon the NMDS, there appears to be a strong gradient among the sites as expressed by overstory species composition, with some stands having relatively similar overstory composition across sampled areas while others being more variable (Figure 1). The CASS stands are dominated by northern red oak (QuRu), red maple (AcRu), American beech (FaGr), and eastern hophornbean (OsVi). There also appear to be embedded wet areas in this stand as represented by the presence of black ash (FrNi). The BOAT stand also tends to have similar overstory composition across all the plots sampled. This stand is characterized by bitternut hickory (CaCo), hackberry (CeOc), green ash (FrPe), American elm (UlAm), and American basswood (TiAm). The other five stands share common overstory species, but vary in the dominant species. For example, the overstory of the GP stand is dominated in some areas by American elm, green ash, bigtooth aspen (PoGr), and eastern cottonwood (PoDe), while other areas are characterized by shagbark hickory (CaOv), pignut hickory (CaGl), boxelder (AcNe), common buckthorn (RhCa). This difference may be in response to a past disturbance in the GP stand (as well as other stands in the ordination that show a similar pattern) as aspen species are considered early-successional species. Similar patterns, albeit with shifts in overstory dominance associated with other species, are observed for the CASS-S, EVON-N, and EVON-S stands. The POOL stand was relatively consistent in overstory composition across sampled areas, being dominated by silver maple (AcSh), sugar maple (AcSa), and swamp white oak (QuBi), and are suggestive of wet-mesic conditions.

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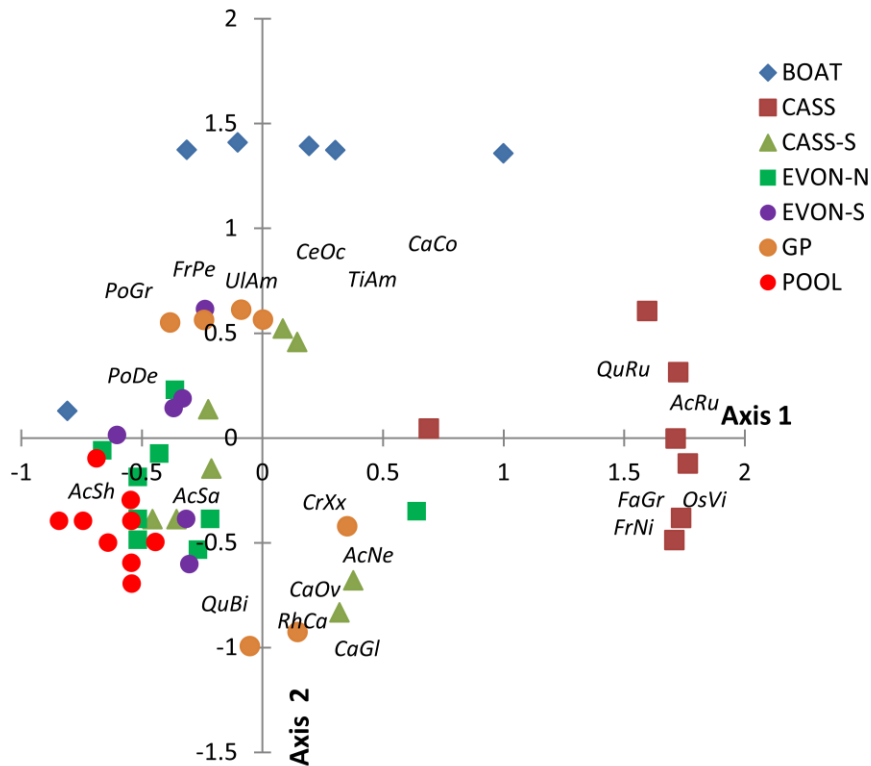
Fig. 1. NMDS ordination of overstory species based upon relative basal area for seven stands at Shiawassee National Wildlife Refuge. Species acronyms correspond to first two letter of genus and species (e.g., AcRu = *Acer rubrum*).

Comparison of Overall Overstory Composition. To help support the patterns observed in the NMDS (Figure 1), as well as described in the SUMMARY TABLES & FIGURES document for the Shiawassee NWR (Corace et al 2011), we also conducted a Multi-Response Permutation Procedure (MRPP) to examine if there are differences in the overall overstory composition among the seven stands. MRPP is a non-parametric technique that tests the hypothesis that there is no difference between groups of entities, in this case the overstory composition of stands at Shiawassee NWR.

We conducted a MRPP using Sorenson's distance and PC-ORD (ver. 5.0) software. Overall, there is statistically significant difference in the overstory composition among the seven stands (T = -8.121; A = 0.186; $P < 0.001$). Thus, the results of the MRPP support the conclusion of the NMDS ordination that there are distinct overstory compositions associated with the forest stands at Shiawassee NWR. We also calculated post-hoc pairwise comparisons between stands and found the following statistically significant differences (α= 0.05):

- **BOAT** has significantly different overstory composition than CASS ($P = 0.002$), EVON-N ($P = 0.019$), and POOL ($P < 0.001$).
- **CASS** has significantly different overstory composition than BOAT ($P = 0.002$), CASS-S ($P = 0.002$), EVON-N ($P < 0.001$), EVON-S ($P < 0.001$), GP ($P < 0.001$) and POOL ($P < 0.001$).

2

- **CASS-S** has significantly different overstory composition than CASS (P = 0.002), GP (P =0.050) and POOL (P < 0.007).
- **EVON-N** has significantly different overstory composition than BOAT (P = 0.19), CASS (P < 0.001), and GP (P =0.001).
- **EVON-S** has significantly different overstory composition than CASS (P < 0.001), GP (P =0.050), and POOL (P < 0.001).
- **GP** has significantly different overstory composition than CASS (P < 0.001), CASS-S (P =0.050), EVON-N (P = 0.001), EVON-S (P =0.050), and POOL (P < 0.001).
- **POOL** has significantly different overstory composition than BOAT (P < 0.001), (CASS (P < 0.001), CASS-S (P =0.007), EVON-S (P =0.007), and GP (P < 0.001).

Analysis Implications. These basic results confirm the summary information developed by Corace et al. (2011). Specifically, there are unique forest communities at Shiawassee NWR that are dominated by a mixture of species that most likely reflect dominant environmental and possibly disturbance gradients. This suggests that a "one-size-fits-all" approach to forest management would not be appropriate as there are stands at Shiawassee NWR that have unique overstory compositions that may require specific management recommendations and guidelines depending on management objectives. For example, based upon these data, there appear to be upland forests dominated by a variety of hardwood species that are in varying degrees of condition and/or development, as well as wet-mesic forests that may approach being classified as forested wetlands (e.g., POOL stand, areas of the GP and CASS-S stands). Management activities, including forest ecosystem restoration practices, would need to be tailored for each specific condition.

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References:

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